Vol. 106 No. 6 March 20, 1943

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Chemical Division

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EL DORADO, ARKANSAS

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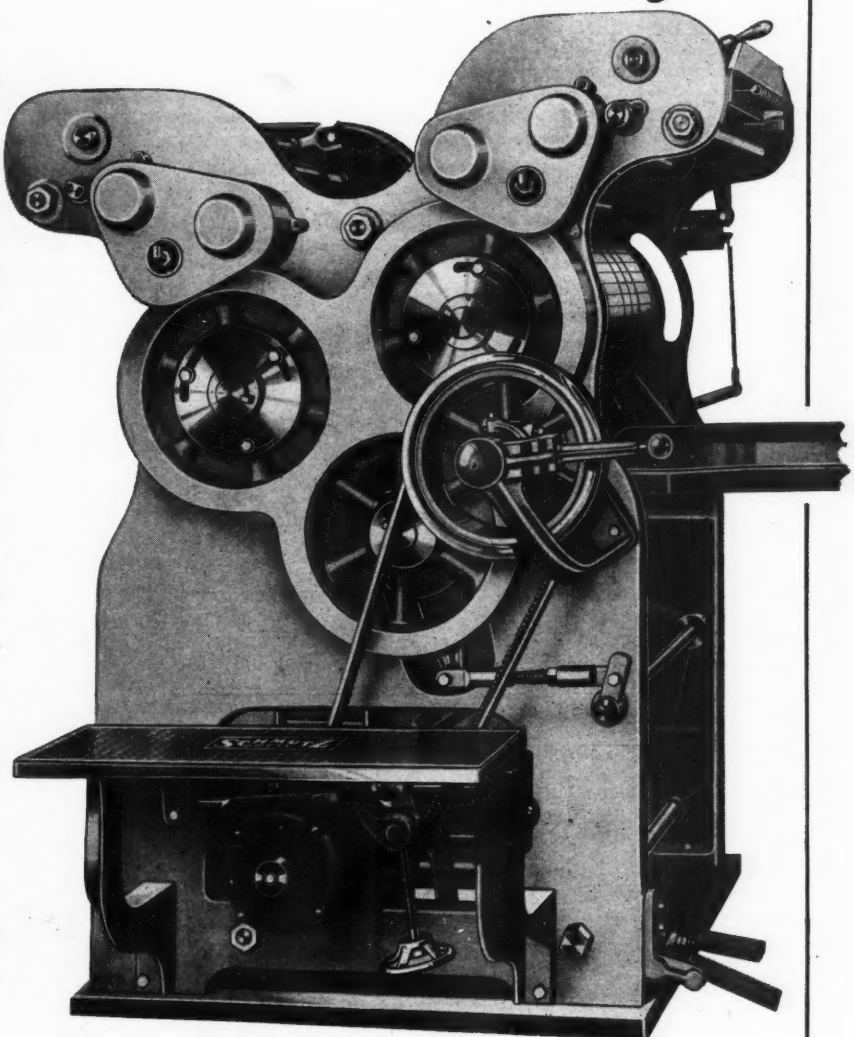

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The American FERTILIZER

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Fertilizers Double and Treble Hay and Grain Yields in Northern Wisconsin

By C. J. CHAPMAN

Soils Department, University of Wisconsin, Madison, Wisconsin

HAY and grain yields doubled and trebled by fertilizing! This sounds fantastic; but if you have the patience to read this article, I am going to try to prove the statement. At any rate, I shall tell you the story of some of the most amazing crop responses in the history of my 31 years of demonstrating fertilizers in Wisconsin.

We have just completed three years of extensive demonstrational work with fertilizers in northern Wisconsin and, based on the results of more than 200 test plots in the Lake Superior and northern Wisconsin area, I am convinced that a high percentage of the farmers in this part of the State can double, and many of them even treble, their production of timothy hay, pasture, and grain crops through the use of nitrogen and mineral fertilizers.

This program of demonstrations came about as a result of a demand on the part of county agents in these northern counties for help from the College of Agriculture. "What's wrong with northern Wisconsin's agriculture?" This was the question that during the summer of 1944 was put to the administrative heads of our College of Agriculture. The initial step was a conference of these administrative heads, including departmental chairmen and as well county agents and farm leaders from this northern area.

The livestock people suggested there was much to be desired in the way of herd improvement. "Too many scrub cows! Poor quality feed!" they said. They suggested a program of artificial insemination for the dairy farmers of this northern area (now in operation in several of these counties).

The economists voiced their suggestions. "Cut costs of production! Increase the output of quality feed! Better cows and a greater diversification of farm income!"

The crops people summed up the situation in very few words: "Convert the weed-infested hay and pasture meadows of the area into good high-quality, protein-rich forage crops! Grow more grain and practice a system of shorter rotations!"

But finally Professor Emil Truog, Chairman of the Department of Soils, was called upon to make his comments and suggestions, and I am told that for a period of one hour and eight minutes he elaborated on the basic fundamentals of soil fertility, lime, and fertilizers, and the importance of mineral-rich soils as a starting place in a program of crop improvement and the eventual development of better herds of dairy cattle. Without question, Professor Truog had hit upon the real and basic reason for low yields and poor quality of hay and grain.

True, there are other factors which contribute to the low income and low level standards of living on the farms in this area. Many of the small farms are not capable of producing sufficient income to support a farmer's family and so sources of income other than the farm, such as work in the woods,

*Reprinted from "Better Crops with Plant Food," January, 1948.

mines, and sawmills, have resulted in a makeshift system of part-time farming. But by and large, this is not the real cause for the general low level of farm income.

True, there is the factor of climate. Corn in these northern countries, especially on the red clay of the lake shore country, is not a dependable crop, with the result that very few acres are grown. The choice of crops is limited. It is not an easy matter to keep the land in a regular system of crop rotation. However, much in the way of crop improvement could be done if the farmers would break up at more frequent intervals their old timothy quackgrass meadows and grow more fall-seeded winter wheat and rye or sow more spring grain and seed down with legume mixtures.

It's true also that the physical factors of working the red clay soils, the breaking of these old timothy quackgrass meadows, and the fitting of a satisfactory seedbed for fall of spring grains are serious handicaps.

But coming back to Professor Truog's insistence that soil fertility factors were the basic cause for low crop yields—"All right! If it's soil fertility, then it's your baby!" they all told him. "The chief emphasis at the outset," they said, "should be given to a program of soil improvement."

Demonstration Difficulties

I was the Extension Specialist in Soils, and so I agreed to start out on an intensive program of demonstrations in this northern Wisconsin area. I knew what this meant, too. Three hundred miles from Madison—a rough and tough country—long distances between farms—poor roads—cold, wet springs—being away from home for several weeks at a stretch. But I didn't know what I have since learned through my work and association with these farmers and what has been a compensating factor for the long hours, time and effort put into these three years of extension education. It is just this: The farmers of northern Wisconsin are a friendly people—a fine people—they are cooperative—they are hungry for information and appreciative of what you do for them. Many of these farmers and their families are struggling for the necessities of life; but, on the other hand, are happy and, for the most part, contented with their lot. This country was settled by Finns, Croatians, Yugoslavs, Scandinavians, the overflow from the mines and the lumbercamps, along with a migration of folks who had moved in from the cities or farms farther south. Many a settler had been influenced by the lure of the advertisements of the northern land companies: "Cheap land! Make a farm for yourself and family! Cloverland country!"

There are compensating factors, too, which contribute to the satisfaction of living. The country abounds in game. The thousands of lakes and streams are well-stocked with fish, and there is something in the atmosphere of the northern woods that lends itself to a feeling of self-security and contentment.

As I appraised the situation at the outset, I saw the thousands of acres of weed-infested timothy and quackgrass meadows. Hay and pasture are the major crops. Some sixty to seventy-five per cent of the cropland acreage is devoted to hay (mostly timothy and quack). The number one crying deficiency and the factor most responsible for low yields on these timothy and grassland pastures appeared to be nitrogen. Evidence of a lack of nitrogen can be seen during the early months of spring and summer in the urine spots in these old timothy meadows and pastures. Liquid manure is rich in nitrogen. The lush, rank, dark green spots are a most convincing demonstration of what nitrogen fertilizer will do to promote the growth of grasses.

Timothy Meadows

Our first approach to a program of increased feed production was centered around the use of nitrogen fertilizer for these old timothy meadows. We started off by setting up a total of 27 acre plots which were top-dressed with ammonium nitrate at the rate of 200 pounds per acre. The demonstrations were established on farms widely distributed over four northern counties.

As anticipated, the response of timothy to the application of ammonium nitrate was tremendous. Summer meetings were held on the plots and neighbors in the community were invited in to see the amazing results. When harvested and the yields calculated, there were increases ranging from three-fourths of a ton to as much as two tons more hay per acre. It should be stated right here that 1945 was a year of ample rainfall in the spring and that a high percentage of the plots were set up on the heavier red clay soils in the Lake Superior area, soils which are fairly well supplied with minerals.

The average increase for all plots was better than a ton of hay per acre (see Table No. 1) and it was better quality hay. There were, however, a few plots on the Kennan loams and sandier types of soils where the response of timothy to straight ammonium nitrate was disappointing. The timothy and June grass greened up but didn't make

much of an increase in yield. The reason was later revealed in the amazing responses which showed up on these same farms on grain plots where phosphate and potash treatments were applied.

In 1946 and 1947 we made some comparisons of minerals (phosphate and potash) as a supplement to ammonium nitrate versus ammonium nitrate only. In 1947 we made a direct comparison of 0-20-0 versus 0-20-20 in order to check the response to potash in addition to phosphate. To our utter amazement, we found that where the 0-20-0 or 0-20-20 was applied in addition to ammonium nitrate on these thinner, poorer, depleted soils the response of timothy was tremendous and there was also a marked increase in the growth of clover, especially where potash mixtures were used. On the heavier silt and clay loam soils where the fertility level had been maintained through more recent applications of manure, nitrogen alone did produce good increases.

In almost every one of the plots set up in 1947 the strip receiving the combination of nitrate plus 0-20-20 made the largest increase in yield and showed the greatest profit. Table No. 2 shows the average yields for 17 of the 22 demonstrations set up in 1947 where a direct comparison of ammonium nitrate only versus ammonium nitrate plus 0-20-0 or 0-20-20 was made. (Due to the very late spring, the application of nitrogen and other fertilizers was delayed in many cases until the middle of May. By way of further explanation, it should be stated that many of our tests in 1947 were located on the Kennan loams and sandy loams which have proved to be extremely low in both phosphorus and potassium. These factors may, in part, explain why nitrogen only did not make as large an average increase in yields in 1947 as is shown in the data for 1945.)

It is apparent from the results of our test plots in 1946 and again in 1947 that minerals (phosphate and potash) are needed to supplement treatment with straight nitrogen fertilizer on the thinner, poorer, depleted soils of this area. Our test demonstrations in 1947 further bring out the need for potash in addition to phosphate.

And so, on most of these old timothy meadows in northern Wisconsin, especially those fields where little or no manure has been used for many years and where no commercial fertilizer (phosphate or phosphate-

TABLE 1
AVERAGE OF TWENTY-SEVEN DEMONSTRATIONS—1945—WHERE AMMONIUM NITRATE AT 200 LB. PER ACRE WAS COMPARED TO NO TREATMENT

Crop	Treatment and Rate Per Acre	Av. Yield Per Acre	Av. Increase Per Acre	Cost of Fertilizer[1]	Value of Increase[2]	Profit Over Cost of Fertilizer
Timothy and other grass hays (10% clover	Ammonium nitrate at 200 lb.....	4,921	2,185	$6.00	$21.85	$15.85
	No fertilizer.....	2,736				

[1] Ammonium nitrate figured at $60 per ton.
[2] Hay figured at $20 per ton.

TABLE 2
AVERAGE OF SEVENTEEN DEMONSTRATIONS—1947—WHERE AMMONIUM NITRATE ONLY WAS COMPARED WITH AMMONIUM NITRATE SUPPLEMENTED WITH 0-20-0 AND 0-20-20

Crop	Treatment and Rate Per Acre	Av. Yield Per Acre	Av. Increase Per Acre	Cost of Fertilizer[1]	Value of Increase[2]	Profit Over Cost of Fertilizer
Timothy and other grass hays (10% clover)	Ammonium nitrate at 200 lb.	3,116	1,249	$6.00	$12.49	$6.49
	Ammonium nitrate at 200 lb. plus 0-20-0 at 250 lb.	3,932	2,065	7.88	20.65	12.77
	Ammonium nitrate at 200 lb. plus 0-20-20 at 250 lb.	4,991	3,124	12.67	31.24	18.57
	No fertilizer.....	1,867				

[1] Ammonium nitrate figured at $60 per ton (one-half of the cost of 0-20-0 and 0-20-20 charged here).
[2] Hay figured at $20 per ton.

potash mixtures) have been used in recent years, farmers should give these old meadows a treatment of at least 200 pounds per acre of 0-20-20 or its equivalent together with from 150 to 200 pounds per acre of ammonium nitrate or its equivalent in other nitrogen fertilizers such as ammonium sulphate, cyanamide, or nitrate of soda.

Fertilizers for Grain and Legume Seedings

Now comes the most important part of the story. Grain yields doubled and trebled! Residual carryover benefits that double the yield of legume hay the year following! Here is the great opportunity, as I see it, for a vastly improved type of farming and increased feed production in this north country. More of these old timothy and grassland meadows should be broken up and reseeded. Shorter rotations should be followed.

One reason why farmers in this area are reluctant to break up these old timothy and quackgrass meadows is the tremendous physical job of fitting a seedbed for grain and legume grass seedings. It takes three times the tractor power and work normally required to fit a seedbed for grain in central or southern Wisconsin. Furthermore, the farmers say that it's a poor country for grain. "Grain doesn't do well—yields are low," they say. It's true that grain yields for this area are low, oats averaging from 25 to 30 bushels per acre.

But our demonstrations have shown that it is possible to increase yields of oats up to 60, 70, and even 90 bushels per acre through the use of fertilizers. I cannot agree with the farmers that this is a poor country for grain. Rather, I maintain that this north country is a "natural" for grain—cool nights, longer growing days, and, for the most part, better moisture relationships.

Take the case of Victor Salo who lives four miles south of Hurley on U. S. Highway 51. On his farm in 1946 the unfertilized plot yielded 23.3 bushels per acre. With 250 pounds of 0-20-0 per acre, the yield jumped to 76.3 bushels per acre. The top yield on the Salo plots was achieved on the 0-20-20 strip where 100 pounds of ammonium nitrate per acre were applied as a supplement to the phosphate-potash mixture (88.9 bushels per acre).

The grain yields on these plots tell only part of the story. What about residual carryover benefits to seedings of clover? On the Salo plots in 1947 the yield of clover and timothy was stepped up from 3,825 pounds per acre on the no-fertilizer plot to 6,975 pounds per acre on the 0-20-20 plot. (Hay yields represent two cuttings, the second crop estimated at 50 per cent of the first.)

When we added together the total value of the increase in grain for 1946 plus the value of the increase in hay for 1947 on the plot receiving 250 pounds of 0-20-20 plus 100 pounds of ammonium nitrate, we arrived at a figure of $97.63. The cost of the fertilizer applied on this plot was $8.65, making a net return in two years over and above the cost of fertilizer of $88.98. This represents considerably more than the actual value of the land.

Mr. Salo was pleased and excited over these results. He asked me, in his broken, Finnish accent: "What were the numbers of the fertilizer you used on my grain?" I have since written him in detail giving explicit directions for the kind and amount of fertilizer for the various crops on his farm. (We conducted also a top-dressing plot on Mr. Salo's timothy hay meadow using a combination of ammonium nitrate with 0-20-20 and the response was likewise spectacular. Yields of hay were stepped up from a low of 1,725 pounds per acre (mostly weeds) on the unfertilized plot to 5,925 pounds per acre on the plot receiving the fertilizer.)

One can imagine what such demonstrations do for these farmers. Victor Salo had worked a good 30 years to grub out the stumps and make a farm for himself and his family. As a young man and for many years he worked in the lumber camps, saved his money, and poured it into this farm. But as time went on the crops became poorer and poorer. He was fighting a losing battle. Now he knows that his land is capable of producing abundant crops of grain, grass, and legume hay. With fertilizers he cannot only double, but treble, the yield of crops on his farm. And this story of the amazing response to fertilizer treatment could be repeated over and over again if space permitted.

Why are these soils so deficient in plant food? I'm sure of one thing—they didn't have too large a native store of either phosphorus, potassium, or lime when they were brought under cultivation. This north country supported a tremendous growth of white pine, hemlock, and hardwoods in the early days and these giants of a primeval forest sapped a lot of fertility from the soils. While northern Wisconsin's agriculture is young, this land had been cropped over a period of a hundred years at the time when the great virgin forests of the area were logged, and the second growth timber and pulpwood

(Continued on page 24)

Lion Oil Company Purchases El Dorado Plant

Lion Oil Company has purchased from the United States Government the chemical plant near El Dorado, Arkansas. Simultaneously the Company revealed that it has issued $20,000,000 in new 3¼ per cent sinking fund debentures due January 1, 1968. Proceeds of the new issue have been used to finance the purchase of the plant, call the present outstanding $5,600,000 principal amount of 3¾ per cent sinking fund debentures due 1959, and increase cash and working capital of the company.

The chemical plant, formerly known as Ozark Ordnance Works, is one of the largest United States producers of anhydrous ammonia, ammonium nitrate fertilizer, and nitrogen fertilizer solutions. During the period from May, 1943, until May 13, 1946, Lion Oil Company, through a wholly-owned subsidiary, operated this plant for the Government on a cost-plus-fixed-fee basis. On May 13, 1946 Lion Oil Company took over the plant for private operation under a long-term lease and has been operating it continuously since that time.

According to T. H. Barton, chairman of the board, outright purchase of the plant will permit greater flexibility in the operation of these facilities and make the plant more readily available for capital additions and expansion which may be expected in the long-term growth and development of the chemical division of the company.

National Committee Announced for Soil and Fertilizer Research

A national Soil and Fertilizer Research Committee consisting of scientists from the Land Grant Colleges and the U. S. Department of Agriculture has been organized to assist in planning national and regional studies of soils, fertilizer, and irrigation, it was announced on March 9th.

Dr. H. C. Knoblauch of the Office of Experiment Stations was elected chairman of the 10-man committee. Other members are: Dr. F. E. Bear, New Jersey Experiment Station, New Brunswick; Dr. W. R. Paden, South Carolina Experiment Station, Clemson; Dr. R. W. Cummings, North Carolina Experiment Station, Raleigh; Dr. C. O. Rost, University of Minnesota, St. Paul; Dr. D. W. Thorne, Utah Experiment Station, Logan; Dr. W. T. McGeorge, Arizona Experiment Station, Tucson; Dr. Mark L. Nichols, Soil Conservation Service; and Dr. Frank W. Parker and Dr. K. D. Jacob, Bureau of Plant Industry, Soils and Agricultural Engineering.

The committee was formally organized following a three-day conference held early this month at Plant Industry Station, Beltsville, Md. It will consider the national aspects of soil, fertilizer, and irrigation research and promote the coordination of State and Federal investigations in this field.

While the Committee does not include any representatives of the fertilizer industry, it will cooperate with the latter's experimental work.

AMERICAN PLANT FOOD COUNCIL ENTERTAINS SOUTHERN AGRICULTURAL WORKERS

One of the highlights of the 45th annual convention of the Association of Southern Agricultural Workers was a breakfast given by the American Plant Food Council in honor of the Association Workers. Shown with Clifton A. Woodrum (left), president of the Council, are some of the nationally-known agricultural leaders who were guests on the occasion. They are (left to right) Dr. R. Frank Poole, president of Clemson Agricultural College and newly-elected president of the Association; W. A. Minor, Assistant to the Secretary of Agriculture; Dr. W. V. Lambert, Research Administrator, U.S.D.A. Agricultural Research Administration; Dr. Robert M. Salter, chief, U.S.D.A. Bureau of Plant Industry, Soils and Agricultural Engineering; and Dr. M. L. Wilson, director, U.S.D.A. Extension Work

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Legumes Are Splendid, But . . .

Legumes crops are splendid for building up nitrogen supplies in the soil but, contrary to an idea prevalent among many farmers, they fail to accomplish this purpose when harvested for hay, according to Dr. I. E. Miles, chief of the Soil-Testing Division of the North Carolina Department of Agriculture.

"Actually," the soil chemist added, "the nitrogen content of the soil is depleted when legume hay is harvested. Scientific studies conducted in recent years show that most of the nitrogen stored in legume plants, especially at the harvest stage of growth, is found in the stem structure, not in the roots. It follows, therefore, that the crop should be left to the land if it is desired to build up the nitrogen content of the soil."

Another False Idea

Dr. Miles also scotched a common belief that the larger the number and size of nodules on the roots of legumes, the more nitrogen they produce and store. Research has shown, he explained, that this is not necessarily true. The legume Sesbania, it was found, nodulates most profusely and yet stores less nitrogen than most legumes commonly used for cover crops.

The number, size and shape of nodules appeared to have little or no effect upon the amount of nitrogen stored in the plants. It was found, however, that the percentage of nitrogen was much higher in the nodules than in other parts of the plants. But the total weight of the nodules in relation to the whole plant was so small that they could be disregarded. An average of all the legumes studies indicated that at the mature stage most of the nitrogen was to be found in that part of the plants above the ground.

Other Factors

"These studies," Dr. Miles continued, "raise a very important practical question: Can legumes be grown and removed for hay without depleting the soil of its nitrogen? Of course, it must be recognized that the soil is depleted of its calcium, magnesium, phosphorus and potassium when the crop is removed, unless these minerals are added as fertilizers, lime and manures.

"The proportionate part of the total nitrogen located in the roots varies greatly from one legume to another. For instance, cowpeas, crimson clover, hairy vetch, Crotalaria spectabalis, and Sebania had less than 10 per cent of the total nitrogen located in the roots at the time when they would norm-

ally have been cut for hay. On the other hand, Lespedeza sericea had over 37 per cent, kudzu over 30 per cent, Lespedeza Tennessee 76 and velvet beans over 20 per cent.

"This means that if the portion of the plant above the ground, the stem and leaves, of cowpeas, crimson clover, hairy vetch, etc., is removed, more than 90 per cent of the total nitrogen contained in the entire plant is lost to the soil. Therefore, instead of building the soil, legumes actually deplete it pretty seriously when they are harvested. Of the several legumes studied, Lespedeza sericea and kudzu might be cut and yet leave very considerable amounts of nitrogen stored in their roots under the surface of the ground."

Potash Price Increase Cancelled

The American Potash & Chemical Corporation announced on March 9th the cancellation of the increase in the price of Trona muriate of potash that had recently been made. The previous price of 45.5 cents per unit K_2O in bulk, f.o.b. cars Trona, California, will remain in effect until May 31, 1948.

Fire in Ordnance Works Curtails Nitrogen Exports

The nitrogen export program was seriously affected when a flash fire in the compressor room of the Cactus Ordinance Works at Etter, Texas, on March 6th, halted production of ammonia compounds being manufactured for the Army Ordinance Department for export to occupied areas in Europe and Japan. This plant, which was operated for the Army by the Spencer Chemical Company, produced about 20 per cent of the Army's nitrogen export program.

First reports indicated that the plant would not resume production for another six months, but later information was to the effect that at least partial operation would be possible by the end of April. The Cactus plant has been producing about 6,000 tons of nitrogen per month, equivalent to about 18,000 tons of ammonium nitrate, and this would mean a loss of around 100,000 tons of the latter material from the export schedule.

Government and industry officials have discounted the probability of the Army calling upon commercial producers to make up the shortage caused by the Cactus fire. Such a "loan" had been made in previous years to enable the Army to meet export quotas. Although the amounts thus borrowed were later returned to commercial channels, they were received too late for use during the normal planting season and much criticism was aroused among the fertilizer users in this country. This year the American farmer is being given first consideration and commercial supplies of nitrogen, which are still short of the demand, will be kept intact for domestic use.

Sadler Joins Shuey Staff

Shuey & Company, analytical and consulting chemists of Savannah, Georgia, has announced that Fred S. Sadler has joined their organization. Before the war, Mr. Sadler was associated as a chemist with the Savannah office of the Southern Cotton Oil Company. Since then he has been manager of the refinery of the Italian Cook Oil Company of Lyndhurst, New Jersey.

Wisconsin Tonnage Increases

The farmers of Wisconsin used 364,178 tons of fertilizers during 1947, according to figures compiled by W. B. Griem, of the Wisconsin Department of Agriculture. This represents an increase of 18 per cent over the 1946 production of 306,939 tons. Fertilizer use in Wisconsin has made notable progress in recent years, when it is considered that as late as 1941, the state tonnage was only 76,529.

Of the total fertilizer used, 245,736 tons, or a trifle more than two-thirds, was applied in the spring. In 1946, the spring tonnage accounted for 70 per cent of the total.

Twenty-three grades of complete fertilizers and seven grades of phosphate-potash mixtures were registered, as well as 19 separate materials. The 2-12-6 grade with 92,805 tons and the 3-12-12 grade with 78,927 tons accounted for more than half of the mixed fertilizer sold. Other popular mixtures were: 0-20-10, 36,023 tons; 0-14-7, 25,272 tons; 4-12-8, 21,875 tons; 3-18-9, 13,606 tons. Of the individual materials used, 20 per cent superphosphate accounted for 18,653 tons, and ammonium nitrate for 11,283 tons.

Fertilizers on Fruit

In the March bulletin of the Georgia Experiment Station, Experiment, Georgia, the use of six to seven lb. of a 6-6-6 or a 6-8-6 fertilizer per tree is recommended for the current peach crop. Dewberry and blackberry plantings should receive one-half lb. of 6-8-6 per plant, and this amount should be doubled for bearing plants.

"Copper Hunger" in Plants

"Copper-hunger" in certain areas of eastern and southeastern United States is limiting production of staple crops, plant scientists at Battelle Institute at Columbus, Ohio, have demonstrated.

Results of five years of research on copper in plant nutrition show that tobacco, cotton, potatoes, and soy beans in some states frequently suffer from copper hunger. Because of the lack of this metal in their soils, tobacco farmers may lose 20 per cent of their potential production. Inadequacy of copper is costing farmers of other staple crops up to one dollar out of every possible twenty.

According to Dr. Frank A. Gilbert, Battelle research botanist, copper deficiencies in plants may be completely unrecognizable in the field even by expert observers, since reduced growth is usually the only symptom. Thus, farmers may reap crops for years without realizing that their crops are from a few per cent to 30 per cent below potential production.

This was demonstrated by Battelle in a study of copper-hunger in tobacco. Only in the laboratory could the Institute scientists provide a copper deficiency severe enough for tobacco plants to show visual symptoms of the deficiency. Yet in 72 out of 89 field tests on farms in the tobacco-producing states, substantial dollar returns resulted from treating the land with copper salts.

On one farm in Sampson County, North Carolina, the copper-treated crop gave 27 per cent more tobacco leaf than the untreated crop; on another farm in the same county in another year a 35 per cent increase was noted. In South Carolina, tobacco production was increased from 2 to 19 per cent in five test plantings. In Virginia, the maximum increase was 9 per cent, but this was accompanied by an increase in quality which brought a premium of two cents per pound for the tobacco. Extensive field tests in Kentucky and Indiana did not show pronounced copper deficiency, although in many instances quality was improved.

As explained by Dr. Gilbert, Battelle evidence of benefits from treating soil with copper is conclusive only insofar as tobacco production in certain localities is concerned. Battelle's research on copper-hunger in other crops has not been extensive enough to assure the significance of the results. However, experiments indicate that copper additions to fertilizer may be beneficial to soy beans, cotton, potatoes, and some vegetable crops in certain areas.

In tests on cotton in North Carolina, copper additions gave yield increases from 4 to 6 per cent in three cases out of four. In Illinois, increased soybean yields were obtained.

In the Battelle field studies, copper, in the form of copper sulphate, was applied to the soil along with the regular fertilizer. The amounts used varied from ten to fifty pounds of the sulphate per acre. Both greenhouse and field experiments showed that overapplication of the material is temporarily injurious to plants, although the harmful effects soon disappear.

According to Dr. Gilbert, the study confirms and extends previous knowledge of copper deficiency in plant nutrition. It has been recognized for some time that copper is necessary for plant health. It is one of a number of plant "micronutrients" which are usually ignored in crop fertilizer programs, mainly because of the lack of present-day knowledge. The agricultural science laboratories of the Institute have been concentrating upon studies of "Micronutrients" for several years in the belief that extension of knowledge on this subject would be of practical value to agriculture.

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FERTILIZER MATERIALS MARKET

NEW YORK

Slow Movement of Mixed Fertilizers Crowds Storage Space in Fertilizer Plants. Organic Materila Market Still Slow. Chemical Nitrogen Materials All in Short Supply. Heavy Late Season Demand for Superphosphate Expected

Exclusive Correspondence to "The American Fertilizer"

NEW YORK, March 17, 1948.

The movement of fertilizer to the farms in the northern section of the country was very slow due to weather conditions and some manufacturers were faced with the problem of not being able to take materials into their plants until they were able to move some fertilizer out. In some sections the movement was about 30 days behind last year.

Organics

The market for organic fertilizer materials was still slow with very little buying in evidence. The feed trade still remained out of the market on most feed materials such as tankage and blood, with the result that prices declined further. Tankage and blood were nominally quoted at $7.50 per unit of ammonia ($9.12 per unit N), f.o.b. shipping points, with little interest. Vegetable meals fluctuated with the grain markets and it was hard to name definite prices with most producers soliciting bids. There was some re-sale material offered, which further upset the market.

Fish Meal

Several large lots of imported fish meal arrived at Atlantic ports but it was understood that this material had all been sold previously. The fishing season has not started in the North as yet and there was small interest from the fertilizer trade in future quotations.

Castor Pomace

Some offerings were reported of this material as well as several re-sale lots. Producers seem to feel the production of this material may be cut down shortly, due to lack of business in castor oil.

Nitrogen Solutions

A continued demand was reported for solutions, with buyers accepting delivery as fast as material was being allocated to them. This material is still short of buyers' requirements.

Potash

Many manufacturers are finding themselves short as the season comes to a close, and are eagerly seeking material. A large shipment of foreign potash was reported at two Southern ports which should help the situation some.

Sulphate of Ammonia

No further price changes were heard, with most producers quoting $40.00 per ton, f.o.b. production points. No material was available for sale as producers are sold ahead on contract and demand continues heavy.

Superphosphate

Producers were shipping against old contracts and they expect a heavy late season demand from various sections. Triple superphosphate is in demand for export, with very little material available.

Nitrogenous Material

Some material was reported available for prompt shipment with buyers taking whatever quantities were offered. Some producers still sold out for this season.

Nitrate of Soda

Several boats arrived the past week at various ports which should help the situation. A heavy top-dressing demand is looked for this spring.

Hoof Meal

Very little interest in this material. Fertilizer buyers seem to be well covered for this season.

Ammonium Nitrate

Manufacturers are finding it difficult to obtain deliveries for material previously contracted for. A severe shortage exists in most sections.

PHILADELPHIA

Shipments of Mixed Goods Slow. Demand Heavy for All Fertilizer Materials. Arrival of Foreign Potash Reported

Exclusive Correspondence to "The American Fertilizer"

PHILADELPHIA, March 15, 1948.

Mixed fertilizer is still not moving out so rapidly as it normally should, which continues to jam most of the factories. This condition does not, however, ease the demand for raw materials, which still continues strong.

Sulphate of Ammonia.—Production continues behind the demand, and pressure for prompt shipment is very strong. Stocks are entirely inadequate, and resale material is bringing much more than the original contract prices.

Nitrate of Soda.—Import material continues to arrive regularly and up to schedule. All of this material is under contract and demand is quite persistent for additional quantities.

Ammonium Nitrate.—Stocks and production continue far below requirements, with very heavy demand.

Castor Pomace.—While limited quantities can now be had, the demand is not very great.

Blood, Bone, Tankage.—These organics have not picked up any strength, and while blood and tankage were reported nominally at $8.00 per unit of ammonia ($9.72 per unit N), some sales of tankage were made on a considerably lower basis. Steamed bone meal can be had at $50.00 to $53.00 per ton.

Fish Scrap.—No recent offerings have been reported.

Phosphate Rock.—Production is still behind the demand, but new mining capacity is expected to correct this situation in the near future.

Superphosphate.—The supply position is easier as unfavorable weather still interferes with deliveries of mixed goods. With the advent of good weather, however, it is expected the supply position will tighten materially.

Potash.—The demand for shipments against contracts for domestic production is very heavy, with urgent requests for additional quantities which cannot be supplied. An arrival from Russia is reported, and more is expected within the coming few days. The price is not disclosed at this time.

CHARLESTON

Wet Weather Delays Fertilizer Shipments. Material Demand Still Heavy. Some Resale Materials on the Market

Exclusive Correspondence to "The American Fertilizer"

CHARLESTON, March 15, 1948.

Wet weather in southeastern states has delayed planting operations, resulting in slow movements of mixed goods to the farms. Superphosphate is slightly easier, but nitrogen and potash continue exceedingly tight.

Organics.—Organics continue to be weak in price, with prompt shipment domestic nitrogenous available. Prices around $5.00 to $6.00 per unit of ammonia ($6.08 to $7.30 per unit N), f.o.b. production point, depending on the producer. Foreign nitrogenous was recently quoted at around $6.40 ($7.75 per unit N), ex-vessel South Atlantic ports, for prompt arrival. South American organics continue too high to interest domestic fertilizer buyers.

Castor Pomace.—Producers' prices for spring shipment are around $40.00 per ton, f.o.b.

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production points in the East. Considerable resale material has been offered, some at $38.50 f.o.b. producers' shipping points.

Potash.—Demand continues heavy, but shipments are on schedule against contracts. The discount period ends on March 31, and the spot period will prevail between April 1 to May 15. Some spot material has been promised, but an insufficient quantity to meet demand. A new deposit has been discovered in France, and production is reported running approximately 100 metric tons daily, with an expected increase in production as facilities are improved.

Nitrate of Soda.—Demand continues excessive in relation to supply. Market is described as tight, with no recent change in prices.

Sulphate of Ammonia.—Demand continues exceedingly active and supply insufficient to meet the call. Resale material is at prices considerably higher than contract prices of the producers.

Dried Ground Blood.—Market reports indicate that the prices around Chicago are $7.75 to $8.00 per unit of ammonia ($9.42 to $9.72 per unit N), in bulk. There is practically no demand from the fertilizer trade. The New York market is around $7.50 per unit of ammonia ($9.12 per unit N), and the market is described as "nominal."

Tankage.—Chicago sales are reported recently at $8.00 per unit of ammonia ($9.72 per unit N). Demand is primarily from the feed trade.

Superphosphate.—Supply conditions appear easier in certain production areas, but generally superphosphate is not freely offered. Prices are firm, with no "bargains" available.

Phosphate Rock.—Stocks are not able to be accumulated in the mines, due to steady shipments to acidulators. Transportation conditions in the next few months are expected to ease when one large mine begins operation.

CHICAGO

Fertilizer Mixers Not Buying Organic Materials for Future Needs. Prices on Feed Organics Somewhat Lower

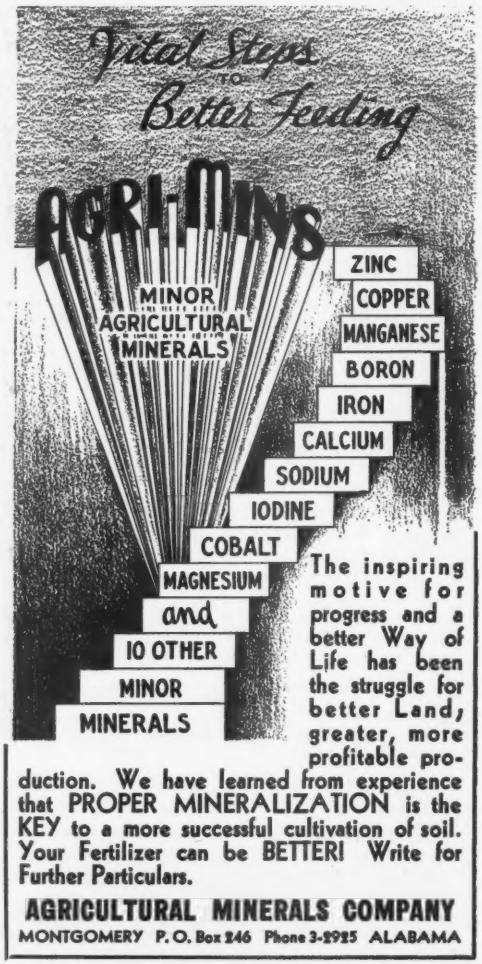
Exclusive Correspondence to "The American Fertilizer"

CHICAGO, March 15, 1948.

The market on fertilizer organics is "marking time" pending clarification of several influencing factors. Producers appear willing to continue selling at steady prices; however, the buyers lack confidence in the future and are operating on a very conservative basis in view of many uncertainties which might cause sharp inventory losses.

Finished materials are moving very slowly, and, for the time being at least, processors are buying only on replacement basis. Dried blood is nominally $7.50 per unit of ammonia ($9.12 per unit N); wet rendered tankage is $7.50 to $8.00 per unit of ammonia ($9.12 to $9.72 per unit N); and dry rendered tankage $1.50 to $1.60 per unit of protein. Steam bone meal, 60 to 70 per cent B. P. L., is $60.00 to $70.00 per ton.

Production of sulphur in the United States during January amounted to 391,214 tons, which is 21,000 tons better than the monthly average for 1947. Shipments were somewhat less than production and consequently stocks on hand at the end of the month increased to 3,373,422 tons.



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Coltrane Appointed North Carolina Agricultural Commissioner

D. S. Coltrane, assistant commissioner of the North Carolina Department of Agriculture for the past 11 years, has been appointed head of the department to fill out the unexpired term of W. Kerr Scott, who resigned in February to become a candidate for the Democratic nomination for governor.

Coltrane was named to the commissionership by Governor R. Gregg Cherry, who commented that he was "mighty glad to have a well qualified man like Coltrane" to take the place. He will serve until a successor, to be chosen in the general election in the fall, assumes office next January.

D. S. Coltrane

When Scott resigned, Coltrane was urged by many friends to become a candidate for the office, subject to the Democratic primary in May, but he chose not to run. Thus far the only announced candidate for the office is Lieutenant Governor L. Y. Ballentine, Wake County dairy farmer.

As assistant commissioner under Scott, Coltrane built a national reputation for himself as an administrator of feed and fertilizer laws. Soon after he became assistant commissioner in 1937 he adopted a policy of holding round-table conferences with farmers, leaders of farm organizations and representatives of industry in planning departmental activities and new regulatory legislation.

As a result, substantial agreement was obtained from most interested groups before legislation was recommended to the general assembly, and changes in regulatory measures proposed by the department met with little opposition. These changes, backed up by impartial enforcement under Coltrane's direction, have given North Carolina a reputation for having some of the finest agricultural control laws in the nation, laws which have proved beneficial to farmers and at the same time acceptable to the industries serving agricultural needs.

Coltrane sponsored amendments to the North Carolina Fertilizer Law which have resulted in increasing the plant food content of fertilizer sold in the state from an average of 15 units per ton to 20 units per ton, and in reducing the number of fertilizer grades from 202 in 1937 to 25 in 1947.

He also promoted a program for the elimination of worthless fillers in feeds, resulting in the adoption of minimum standards for special purpose feeds, and helped in the establishment of a penalty system for feeds found deficient in guaranteed contents. He also rewrote the North Carolina Seed Law, providing for the labeling of seeds as to germination and purity.

Mr. Coltrane, a native of Randolph County, North Carolina, attended Guilford College, near Greensboro, N. C., for two years, and the North Carolina College of Agriculture and Engineering, Raleigh, for two years, finishing in the class of 1917. He served as farm agent in Randolph County for three years and from 1920 until 1937 he was a field representative of the American Limestone Company of Knoxville, Tenn.

He was president of the Association of American Fertilizer Control Officials, 1947; president of the Association of Southern Feed Control Officials, 1947; and president of the Southeastern Food and Drug Officials Association, 1940.

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Maryland Fertilizer Tonnage

Fertilizers used in Maryland during 1947 totaled 255,949 tons, an increase of about 4.5 per cent over the 244,743 tons reported in 1946. These figures have been compiled by L. E. Bopst, state chemist. Complete fertilizers increased from 207,936 tons in 1946 to 219,097 tons in 1947, while superphosphate-potash mixtures dropped from 12,244 tons to 11,310 tons. The average plant food content of the complete fertilizers remained about the same as the previous year: 3.6% N; 11.8% P_2O_5; 7.2% K_2O.

Firms registered during the year numbered 85, with 76 different analyses recorded, of which 50 were complete fertilizers, 5 were superphosphate-potash mixtures, and 21 were individual materials.

Of the 17 grades recommended by the Maryland Department of Agriculture, sales totaled 202,531 tons, or 88 per cent of the total. More than half consisted of the 3-12-6 grade with sales of 118,703 tons. The other leading grades were: 5-10-5, 18,712 tons; 4-12-8, 16,948 tons; 6-8-6, 11,125 tons; 0-14-7, 9,053 tons; 4-8-10, 8,090 tons. Superphosphate (20%) for direct application amounted to 13,230 tons; other individual materials sold included: nitrate of soda, 3,441 tons; ammonium nitrate, 1,752 tons; cyanamid, 1,089 tons.

Increasing Fertilizer Increases Indiana Corn Yields

Last year 98 per cent of Indiana's 2,169 Five-Acre Corn Club members whose yields were checked in 84 counties used fertilizer on their corn, according to reports released by Purdue University agronomists. This compares with the 60 per cent who were fertilizing corn ten years ago.

Eighty-two per cent of the growers applied all the fertilizer in the row or hill with a fertilizer attachment on the corn planter. Fourteen per cent of the growers plowed under fertilizer, most of whom also used a starter fertilizer. A very small number broadcast the fertilizer.

More fertilizer is being applied in the row at planting than ever before. Twenty-nine per cent of the growers used between 150 and 200 pounds per acre in the row in 1946, while six years ago only six per cent used more than 150 pounds. Only one-third of the growers used 100 pounds or less per acre in the hill last year while this was the common practice a few years back.

The fertilizer practices reported by the best Indiana growers conform closely with Purdue experimental results. In a fertilizer experiment conducted at Lafayette for seven years it was found that fertilizer was most efficient when applied in bands by the hill. Fertilizer dropped in the hill is more effective than when drilled in the row either on drilled or checked corn with modern equipment. Drilled corn is more responsive to fertilizer drilled in the row than is checked corn, but in either case more fertilizer is required to give the same yield increase than when the fertilizer is hill dropped. Broadcasting the fertilizer in the surface was the least efficient method of application. Later experiments have shown that larger fertilizer applications than 150 pounds in the hill or 250 pounds in the row, should be plowed under or placed in bands on the "plow sole." Fertilizer for plowing under should be high in nitrogen on upland soils.

Corn responds to both phosphate and potash in row fertilization and, except on well manured land, an analysis such as 0–12–12 is recommended. The use of the quick soil test for available phosphate and potash is a helpful guide to the proper fertilizer analysis to use for corn.

Smaller Bags?

In advocating the use of smaller containers for feed and fertilizer, *The American Agriculturist* recently made the following editorial comment:

"The average age of farmers is well beyond 50 years. It is dangerous for men of that age to continue to lift 100 pounds or more.

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WISCONSIN FERTILIZER TESTS

(Continued from page 10)

which were harvested drew still further on the mineral reserves of these soils.

Getting back to our story of these phenomenal responses of grain and legume hay to treatment with fertilizers, the summary of all grain plots is shown in Table No. 3. These data tell the story of the great opportunity for increasing feed production in northern Wisconsin.

In commenting on the data presented in Table 3, I wish to point out again that while the number one deficiency of these soils appears to be phosphorus, and the response of the grain crops shows this to be true, yet the supplementing of phosphate with potash has in most cases stepped up the yield, even of grain. But look at the response of the hay crop the second year to treatment with potash in combination with phosphate! Clover, in fact all members of the legume family, are heavy feeders on potash. So, it does appear that, considering the influence of fertilizers on the second year hay crop, farmers should use such mixtures as 0-20-20 or 0-12-12 which contain equal parts of phosphate and potash. This is especially true for the lighter, sandier types of soil in the area. The groups of soils, including the Kennan loams and sandy loams, need potash as badly as they need phosphate. On the red clay soils of the Lake Superior fringe our results seem to indicate that a two-to-one ratio of phosphate-potash, such as 0-20-10 or 0-14-7, may be most economical.

Nitrogen Fertilizers for Grains

I haven't said anything yet about the use of nitrogen for grains, and really here is a story that should be told. In all of our demonstration plots on grain we included a treatment of ammonium nitrate as a supplement to 0-20-0 and 0-20-20.

Ammonium nitrate was applied at rates ranging from 65 to 100 pounds per acre as a top-dressing after the grain had been seeded and has paid off in substantial increases in yield of grain on many farms. It usually

TABLE 3

AVERAGE YIELDS OF SEVENTEEN DEMONSTRATIONS—1945, 1946, AND 1947—WHERE THE RESIDUAL CARRY-OVER BENEFIT TO HAY CROP WAS MEASURED AND THE TOTAL VALUE OF INCREASES IN YIELD OF GRAIN AND STRAW PLUS RESIDUAL BENEFIT TO HAY CROP HAVE BEEN ADDED TOGETHER AND PROFIT OVER COST OF FERTILITY CALCULATED

Crop	Treatment and Rate Per Acre	Average Yield Grain	Value of Increase Grain & Straw	Average Yield of Hay [3]	Increase Hay Yields	Value of Increase Grain, Straw, & Hay[1]	Cost of Fertilizer	Net Profit Per Acre
Grain and first year hay following grain	0-20-0 at 270 lb.[2]	65.9	$27.55	5,067	1,357	$44.51	$4.96	$39.55
	0-20-20 at 270 lb.[2]	70.4	31.77	6,470	2,760	66.27	8.33	57.94
	No Fertilizer	38.2		3,710				

[1] Oats figured at 75 cents per bushel; straw at $5 per ton; hay at $25 per ton.
[2] The plots receiving the supplementary treatment with ammonium nitrate were averaged with plots receiving straight 0-20-0 or 0-20-20
[3] These yields represent first and second cuttings the first year following treatment with fertilizer. (The second cutting was estimated at 50% of the first crop.)

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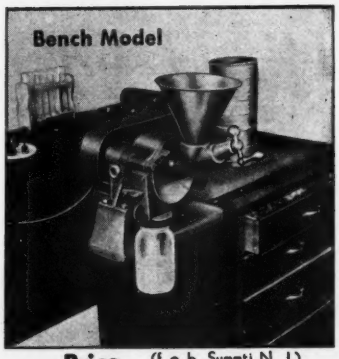

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produces an increase in the growth of straw which in turn makes possible the more complete utilization of the mineral fertilizers—phosphate and potash. We cannot expect minerals to produce increases in grain yields if the number one limiting element is nitrogen. Based on the results of three years' demonstrations I am now recommending quite generally the application of from 75 to 100 pounds per acre of ammonium nitrate (or its equivalent in other nitrogen fertilizers) in addition to the basic treatment with about 300 pounds of 0-20-20 or -0-20-10.

A summary of the yield data of all grain plots, where a comparison of 0-20-0 and 0-20-20 with and without ammonium nitrate was made, is shown in Table 4.

Where soils are only moderately short on

TABLE 4

AVERAGE YIELDS FOR TWENTY-THREE GRAIN PLOTS—1945 AND 1946—WHERE A COMPARISON WAS MADE OF 0-20-0 WITH 0-20-10 AND 0-20-20, WITH AND WITHOUT AMMONIUM NITRATE (NITRATE APPLIED AS A TOP-DRESSING AT AVERAGE RATE OF 87 POUNDS PER ACRE AFTER SEEDING)

Oats figured at average value of 75 cents per bushel; straw at $5 per ton

Treatment (Av. For All Plots)	Yield Per Acre Grain	Yield Per Acre Straw	Bushels Increase Grain	Pounds Increase Straw	Value of Increase Grain & Straw	Cost of Fertilizer	Net Profit Per Acre
270 lb. of 0-20-0	55.2	2,302	16.9	522	$13.98	$3.69	$10.29
270 lb. of 0-20-0 plus 85 lb. of ammonium nitrate	64.2	2,787	25.9	1,007	21.94	6.24	15.70
270 lb. of the average of 0-20-10 and 0-20-20 plots	60.9	2,646	22.6	866	19.12	6.59	12.53
270 lb. of the average of 0-20-10 and 0-20-20 plots plus 85 lb. of ammonium nitrate	70.8	3,279	32.5	1,499	28.12	9.14	18.98
No fertilizer	38.3	1,780					

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nitrogen such mixtures as 3-12-12, 4-12-8, or 3-18-9 may be substituted for 0-20-20 or 0-20-10. However, where there is a definite shortage of nitrogen, that is, where farmers anticipate that the growth of straw will be short, on such fields we do recommend the application of ammonium nitrate or other nitrogen fertilizer along with the phosphate-potash fertilizer.

Summary of Recommendations

1. Lime all acid cropland at rates of from 2 to 4 tons per acre. Have soils tested to determine how much lime to apply.

2. Top-dress timothy or other grassland meadows in the spring with ammonium nitrate or other nitrogen fertilizer. (Apply ammonium nitrate at from 150 to 200 pounds per acre, or ammonium sulphate, cyanamid, or nitrate of soda at rates from 200 to 275 pounds per acre.) Supplement these nitrogen fertilizers with from 200 to 250 pounds of 0-20-20 or 0-20-10 per acre, especially those fields which have been in sod for several years and where little or no manure or commercial fertilizer has been applied.

3. Increase acreage of grain crops—both fall-seeded wheat or rye and spring grain. Seed down with clover or alfalfa, timothy or brome grass. (Lime needed for alfalfa.)

A. For fall-seeded grain, wheat or rye, apply 3-12-12, 4-12-8, 3-18-9, or 2-12-6 at rates up to 300 pounds per acre. Top-dress winter wheat or rye in the spring with ammonium nitrate or other nitrogen fertilizer at rate from 75 to 150 pounds per acre.

B. For spring-seeded grain apply 0-20-20 or 0-20-10 (0-12-12 and 0-14-7 may be substituted) at rates from 250 to 350 pounds per acre. Where straw growth is apt to be short, supplement with ammonium nitrate or other nitrogen fertilizer and apply as a top-dressing after seeding at rate from 75 to 150 pounds per acre. (Where fertilizers are applied broadcast ahead of seeding the ammonium nitrate or other nitrogen fertilizer can be mixed with 0-20-20 or 0-20-10 and applied together. Where the combination fertilizer grain drill is used for sowing grain and fertilizer, *do not* apply ammonium nitrate or other nitrogen fertilizer in contact with seed grain since it will injure the germination of the seed.)

4. Where manure is applied to fields seeded to spring grain or applied as a top-dressing on winter grain—nitrogen fertilizer should be omitted and the rates per acre of 0-20-20 or 0-20-10 can be cut in half.

I know that some readers of this article will say: "Better let this country go back to native forests and wildlife." True, northern Wisconsin is known far and wide as "Vacationland" with its hundreds of summer resorts and good fishing on the thousands of lakes studded in a natural setting of poplar and pine. And it's true that in our program of land zoning some areas have been closed to farming. Some farming areas were so sparsely settled that it was necessary to move these few farmers out and establish them in areas more thickly settled.

On the other hand, there are some well-developed farms and farming areas in these northern counties. The 1940 census records a total of 8,204 farms in the six counties—Bayfield, Ashland, Iron, Price, Vilas, and Sawyer—where our demonstrations were conducted. If we were to include in this so-called north country the upper one-fourth of the State of Wisconsin, we are really dealing with the problems of some 20,000 families who are deriving a large part of their livelihood from the income off farms. Most of the farmers in this area have cast their lot and intend to stay with farming as a vocation. The chances for their fulfilling these intentions are excellent.

NOTE: The writer of this article wishes to acknowledge the liberal contribution of fertilizers by the Spencer Chemical Company, the Coke Oven Ammonia Research Bureau, The Middle West Soil Improvement Committee, and The American Potash Institute. I wish also to acknowledge the wholehearted cooperation and assistance rendered by County Agents Roy J. Holvenstot, Milo Johansen, H. W. Kinney, W. D. Rogan, Russell Johannes, Herman Smith, and Sherman Weiss, and as well the assistance and help given by David Holt, Superintendent of the Ashland Branch Station, and N. O. Stephenson, District Soil conservationist.

Potash Imports Reported

The daily press has reported the recent arrival at Norfolk, Virginia, of a cargo of about 2000 tons of potash from Russia. This is the first potash to reach this country from Russia in almost two years. Other potash shipments from France are expected to arrive at New York and Baltimore before the end of March. No information is available as to the consignees of the above cargos.

Norwegian Nitrate Plant Expands

The Norsk Hydro-electric Company is reported to be enlarging their plant at Heroya, Norway, at a cost of about $25,000,000. This will increase their production of calcium nitrate from 400,000 tons a year to 750,000 tons, making it the largest nitrogen plant in Europe. The company's total capacity will be 1,000,000 tons a year when the additions to the Heroya plant are completed.

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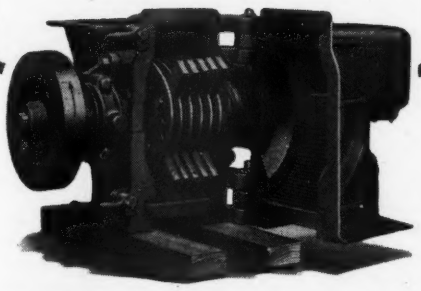

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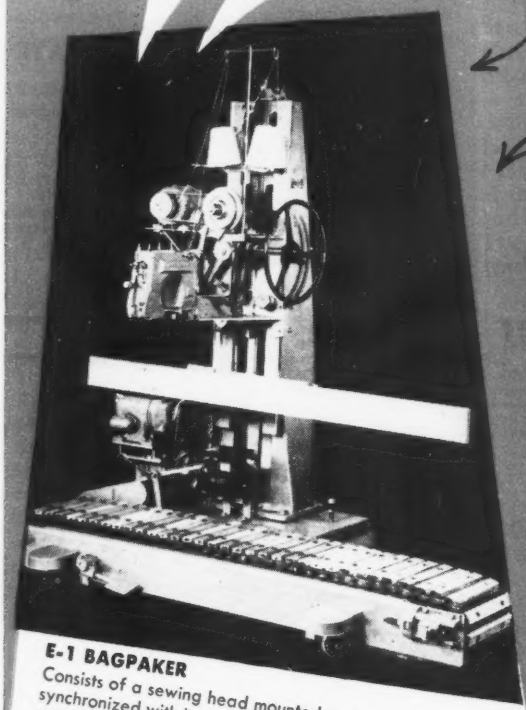

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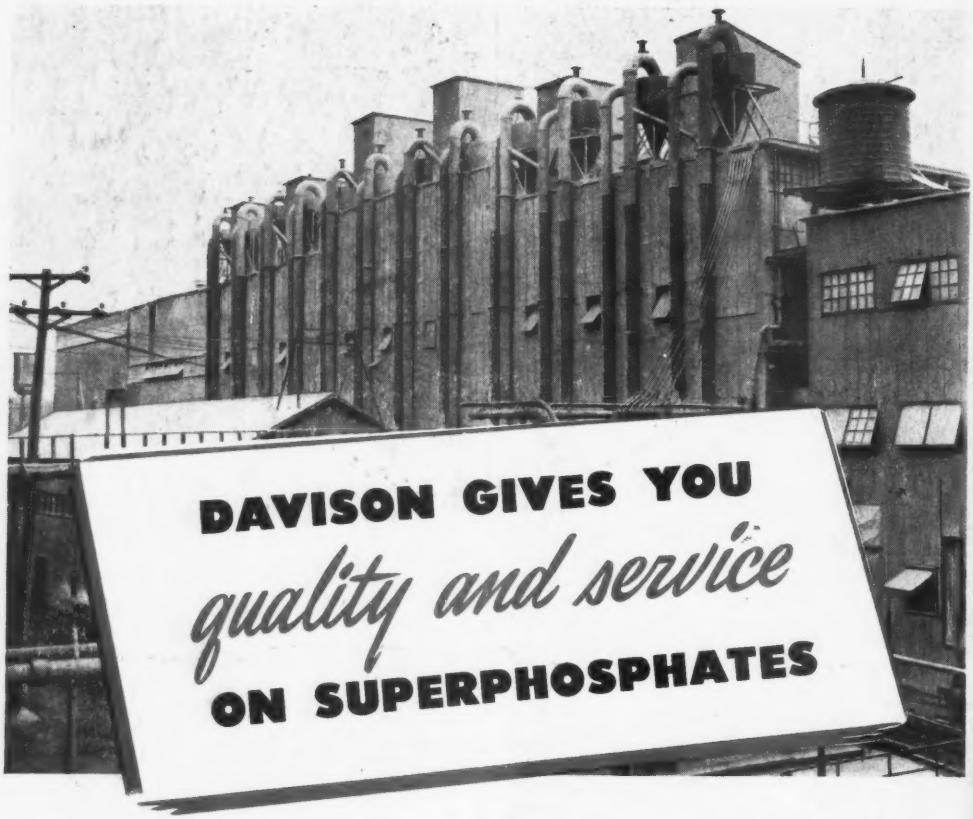

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